

# HGTD Testbeam in CERN

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# 2018 Program

<b>April – May 2018:</b>	✓	Neutron vs Proton Irradiation on Boron implanted CNM 10478 wafers	Completed
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<b>June – July 2018:</b>	✓	Proton irradiated Carbon diffused wafers CNM 10478	Completed
	✓	Un-irradiated Gallium implanted wafers	Completed
	✓	HPK	
	✓	AltiRoC v 0.1	
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<b>September 2018:</b>	✓	Neutron Irradiated Carbon diffused wafers CNM10478	Completed
	✓	Proton Irradiated Gallium Wafers	Completed
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<b>October 2018:</b>	✓	Neutron Irradiated Gallium	
	✓	CNM AIDA – FBK	
	✓	AltiRoC v1.0	

**1<sup>st</sup> Article:** Proton vs Neutron Irradiation on Carbon diffused boron wafers

**2<sup>nd</sup> Article:** Gallium effect on radiation hardness of LGAD sensors in Proton vs Neutron irradiation

III A 13	IV A 14	V A 15
<b>5 B</b> 硼 $2s^2 2p^1$ 10.81	<b>6 C</b> 碳 $2s^2 2p^2$ 12.01	<b>7 N</b> 氮 $2s^2 2p^3$ 14.01
<b>13 Al</b> 铝 $3s^2 3p^1$ 26.98	<b>14 Si</b> 硅 $3s^2 3p^2$ 28.09	<b>15 P</b> 磷 $3s^2 3p^3$ 30.97
<b>31 Ga</b> 镓 $4s^2 4p^1$ 69.72	<b>32 Ge</b> 锗 $4s^2 4p^2$ 72.64	<b>33 As</b> 砷 $4s^2 4p^3$ 74.92



# Testbeam Equipment

## Mechanics, SiPM and FEi4

### Mechanics

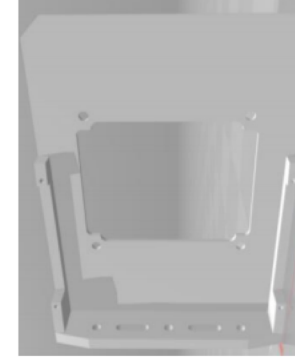
- 10 new board L-shape support brackets
- Easy installation and good alignment
- Simplified mounting
- Closer board distance

### SiPMs

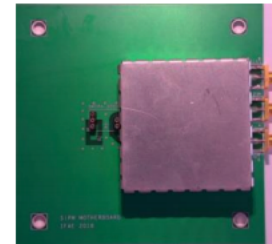
- 5 produced, 4 operational
- 3D printed quartz bar support problematic
  - Poor accuracy
  - Insufficient screw retention power
  - Need aluminum or steel mount
- Board performance poorer than expected
- Higher rise time ( $\sim 1.2\text{nsec}$ ) leading to 36psec resolution
- Higher capacitance due to connector pins?

### MMC3

- More stable than USB PiX
- No synchronization bug with telescope events
- Problematic with old FE-i4 A planes, compatibility questionable
- Only one available, belongs to MPI



Board

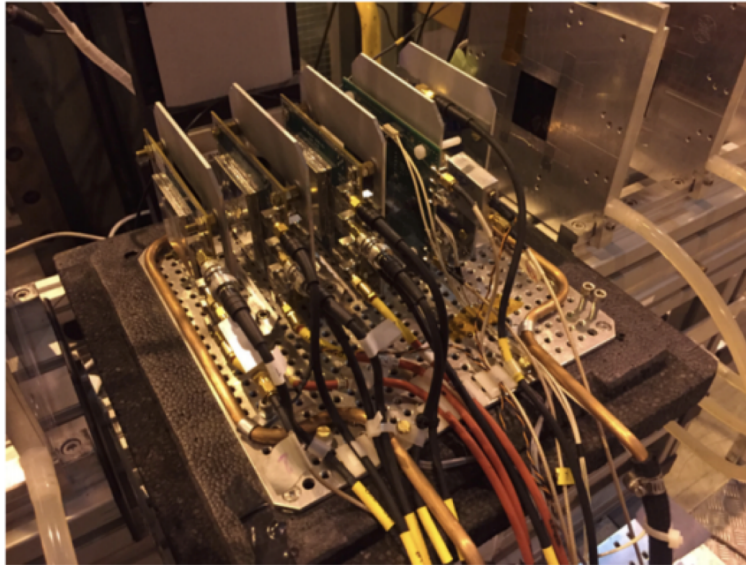


Sensor

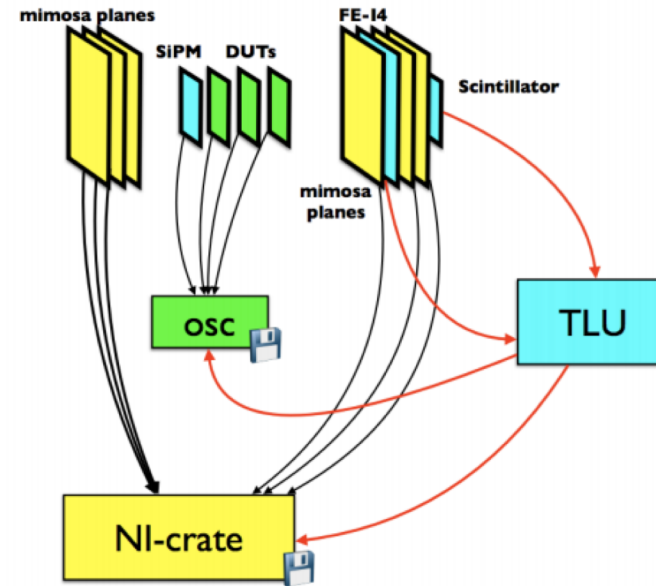


# Setup

- DUTs: LGADs sitting inside a cooling box
- SiPMs: for timing reference which sit in a separate cooling box (closed to light)



(a) Sensors under test



(b) Data acquisition setup

- Mimosa planes: Telescope used for tracking position / efficiency
- FeI4 + Scintillator: used for triggering
- Trigger Logic unit receives signal from FE-I4 and scintillator and sends signal to oscilloscope and NI-crate to save data (two separate files per run)

# Basic Setup

**Telescope:** 6 MIMOSA planes and 4 scintillators

HV for DUTs

**Cold box for DUTs**

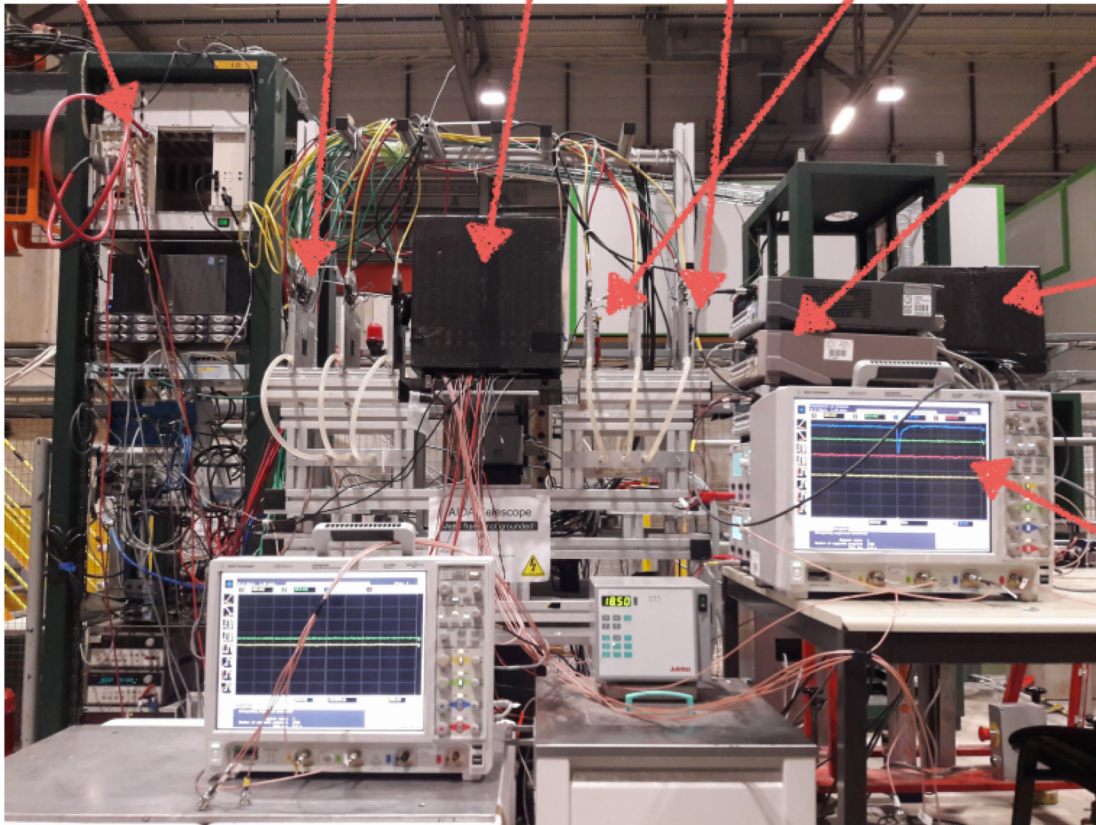
FE-I4

HV for SiPMS  
LV for boards and second stage  
amplifiers

**Cold box for SiPMs**

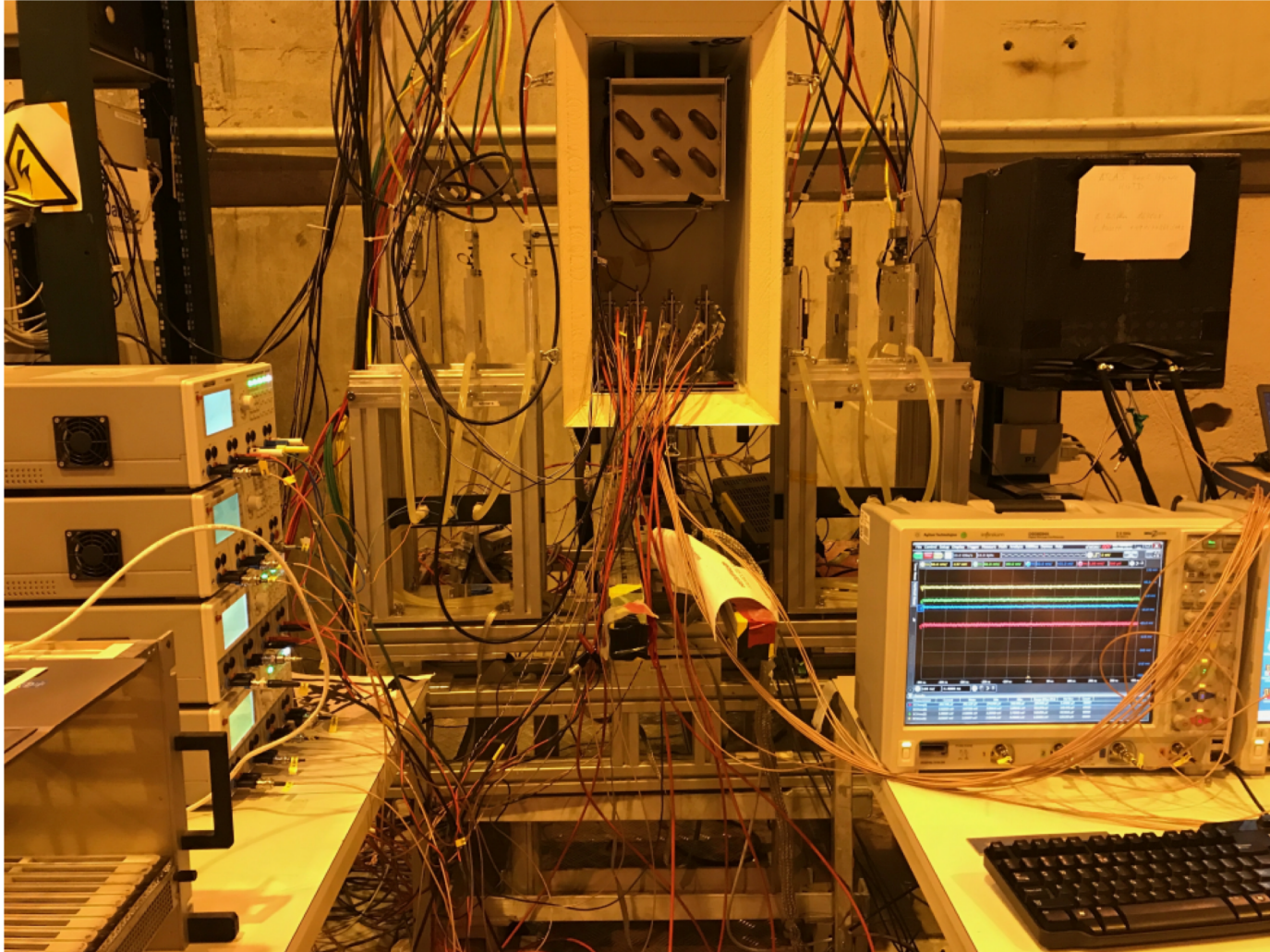
Oscilloscopes for  
read-out

*Signal!*

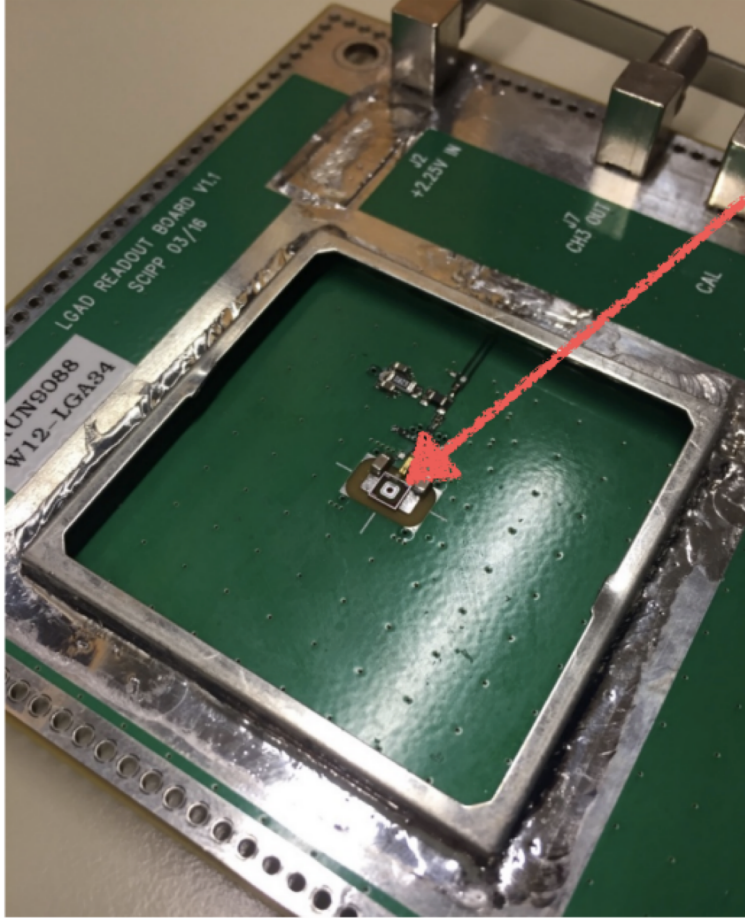




# Sensor setup with box open



# Sensor and readout boards



- LGAD sensor taped to board
- Wire bonded to readout board
- **Cables:**
  - HV in for Sensor - O (100V)
  - LV for board - 2.25 V
  - Calibration (not used in testbeam)
  - CH3 out - signal output
- **An amplifier** is put on the output of the signal → goes to oscilloscope

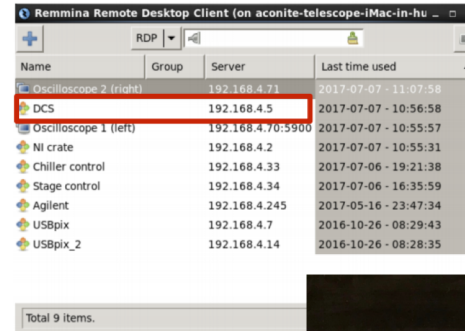
# What should I do as a shifter?

- In case someone will take shifts in CERN or BESIII in future, I summarize something about taking shifts.
- Preparation
  - CERN account (done by email before arrival)
  - CERN card (building 55)
  - Dosimeter (building 55)
  - Access to The Area (through EDH)
  - Helmet, Protective shoes (paid by group)

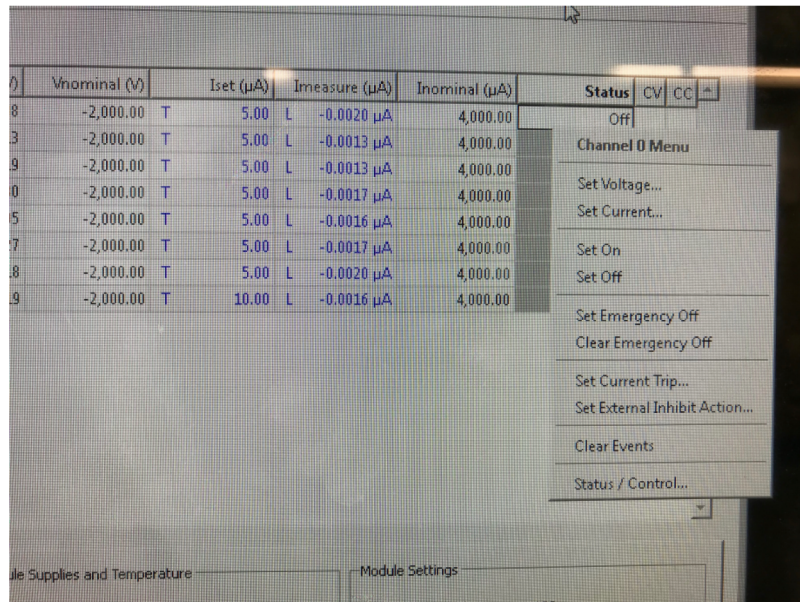


# What should I do as a shifter?

- Voltage Control

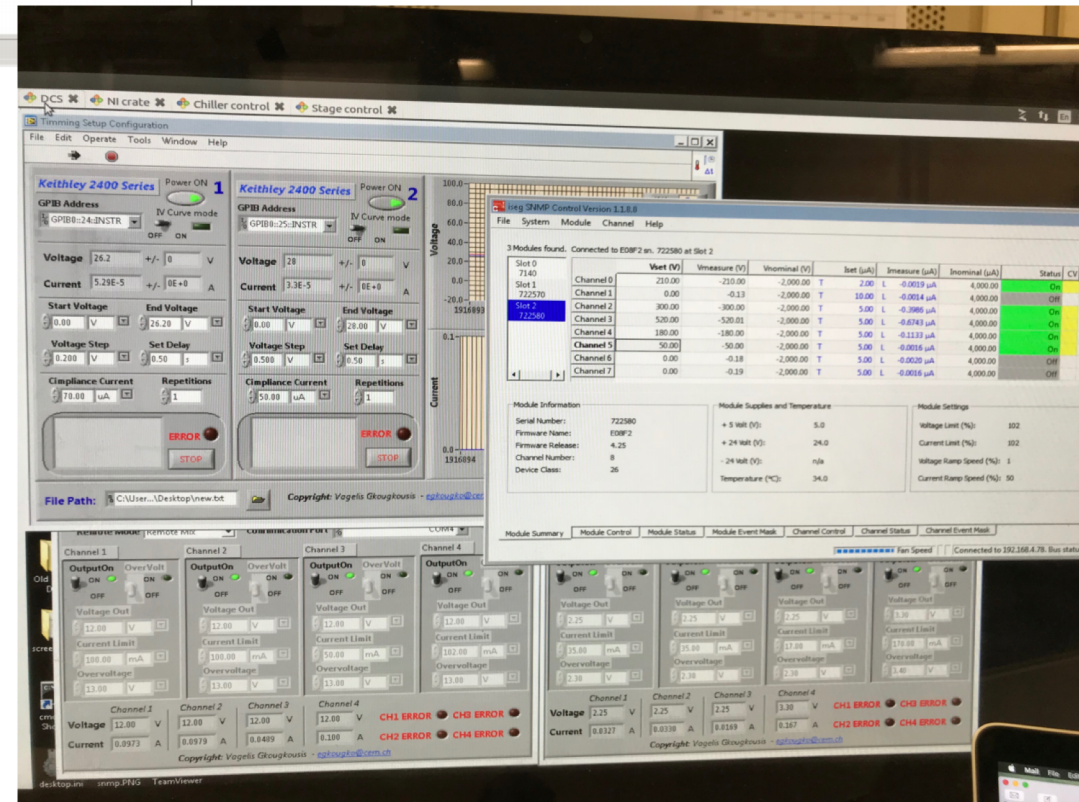


- Set the voltage of the individual sensors from **DCS**
- **Start DCS and check the logbook for which sensors are on which HV channel → it is not obvious!**
- Set compliance in the Iset value
- Set voltage in Vset -> right click on status -> on



'HV' for SiPMs

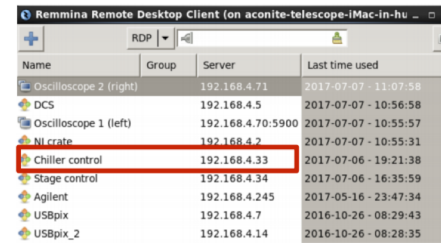
LV for boards and amplifiers



HV for DUTs

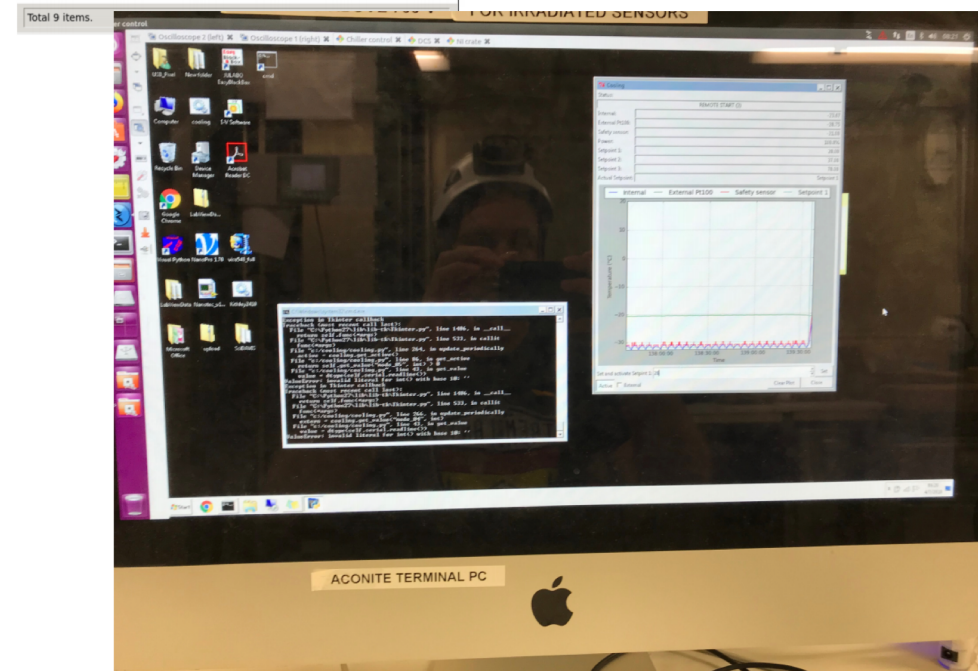
# What should I do as a shifter?

- Temperature Control



Name	Group	Server	Last time used
Oscilloscope 2 (right)		192.168.4.71	2017-07-07 - 11:07:58
DCS		192.168.4.5	2017-07-07 - 10:56:58
Oscilloscope 1 (left)		192.168.4.70-5900	2017-07-07 - 10:55:57
NI crate		192.168.4.2	2017-07-07 - 10:55:31
Chiller control		192.168.4.33	2017-07-06 - 19:21:38
Stage control		192.168.4.34	2017-07-06 - 16:35:59
Agilent		192.168.4.245	2017-05-16 - 23:47:34
USBpix		192.168.4.7	2016-10-26 - 08:29:43
USBpix_2		192.168.4.14	2016-10-26 - 08:28:35

- Nominally we test sensors at -30 C
- Though could also test sensors at -20 C, so shifter may be asked to change the temperature of the chiller
- Also temperature needs to be ramped to + 20 C ahead of sensor replacements

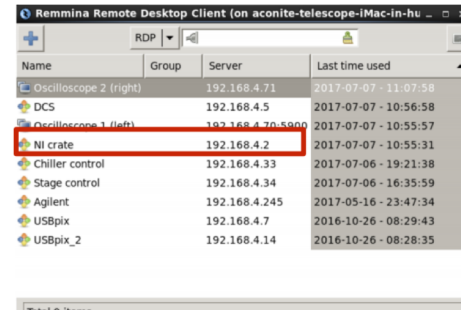


- Click on Chiller control
- Set temperature at bottom under:
  - **“Set end active Setpoint”**
- Can see the temperature on the graph and in the top status

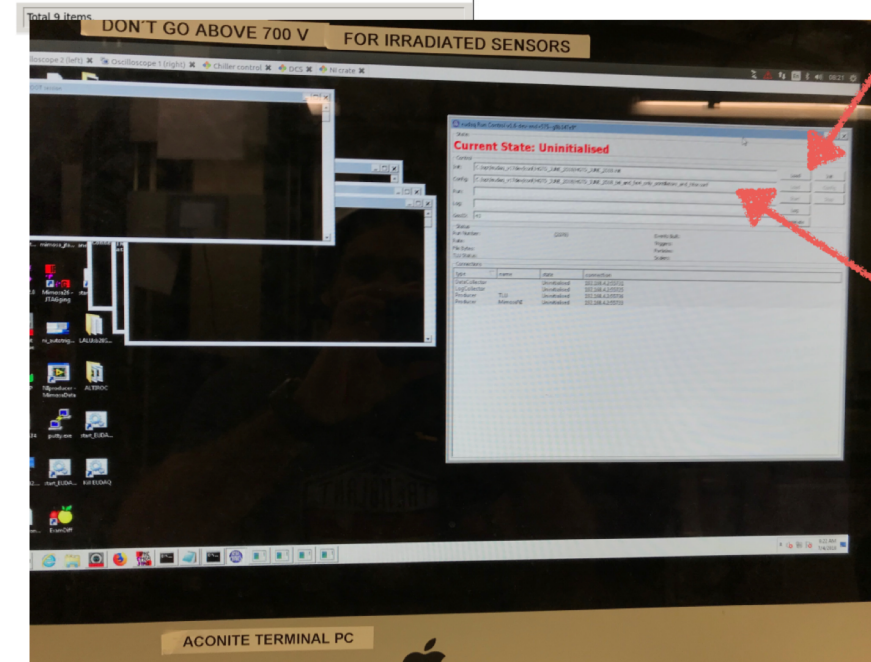


# What should I do as a shifter?

- Start and stop run



- Go to NI crate and start EUDAQ by clicking on icon:
  - **Start EUDET v17!!** *There is more than one EUDET icon!*



- First check initialisation file should be (e.g.):

`C:/opt/eudaq_v17dev/conf/HGTD_JUNE_2018/HGTD_JUNE_2018.init`

- click initialise (*only experts will modify this file*)
- Load and choose the configuration from the window (*different for every batch*)

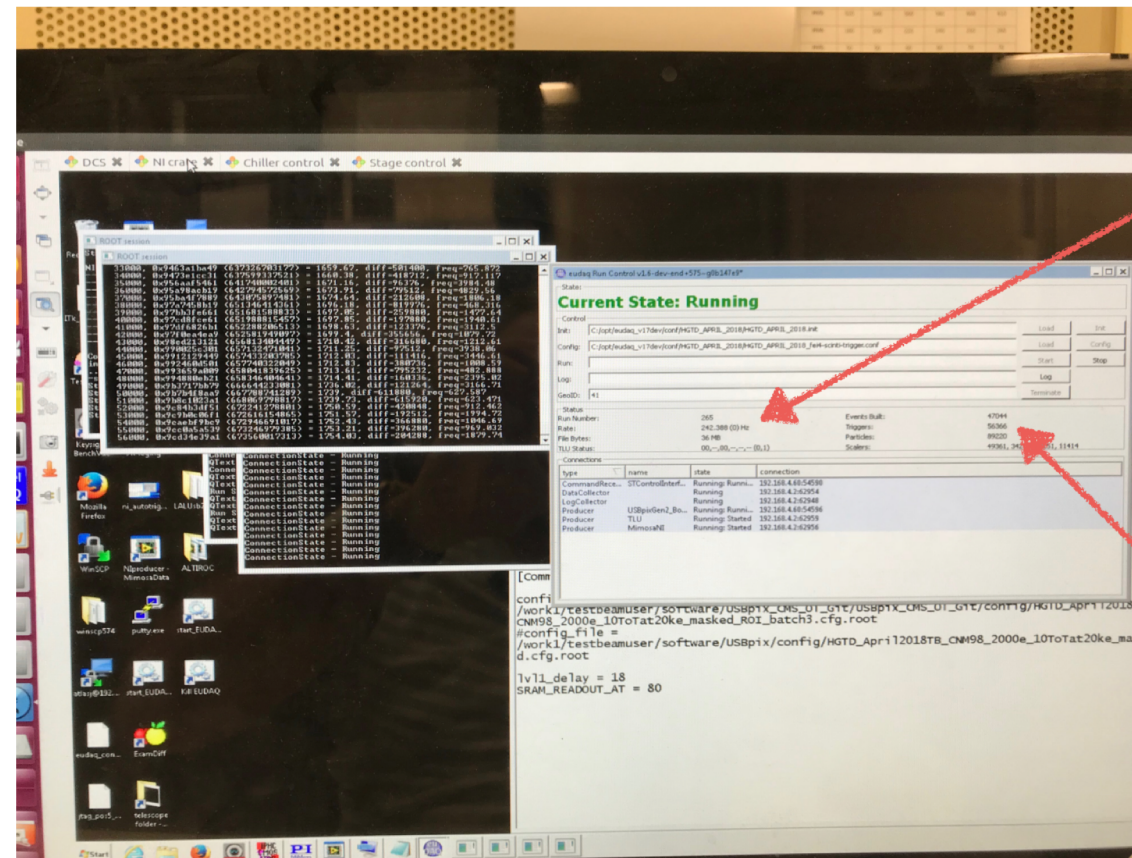
should have dei4\_and\_scintillator in the name

- Above is only done when re-starting EUDAQ
- If all above + DAQ + USBPix done, click start
  - You are now running and taking data!
- Click stop when you want to stop run
  - **Check number of events is -1 DAQ**
  - Copy rate and number of events to log book

# What should I do as a shifter?

- Check Run Parameters

- Now you are running and taking data!
- **Should monitor rate and number of triggers** → compare with DAQ numbers



Rate → dependent on ROI mask and spills from SPS!

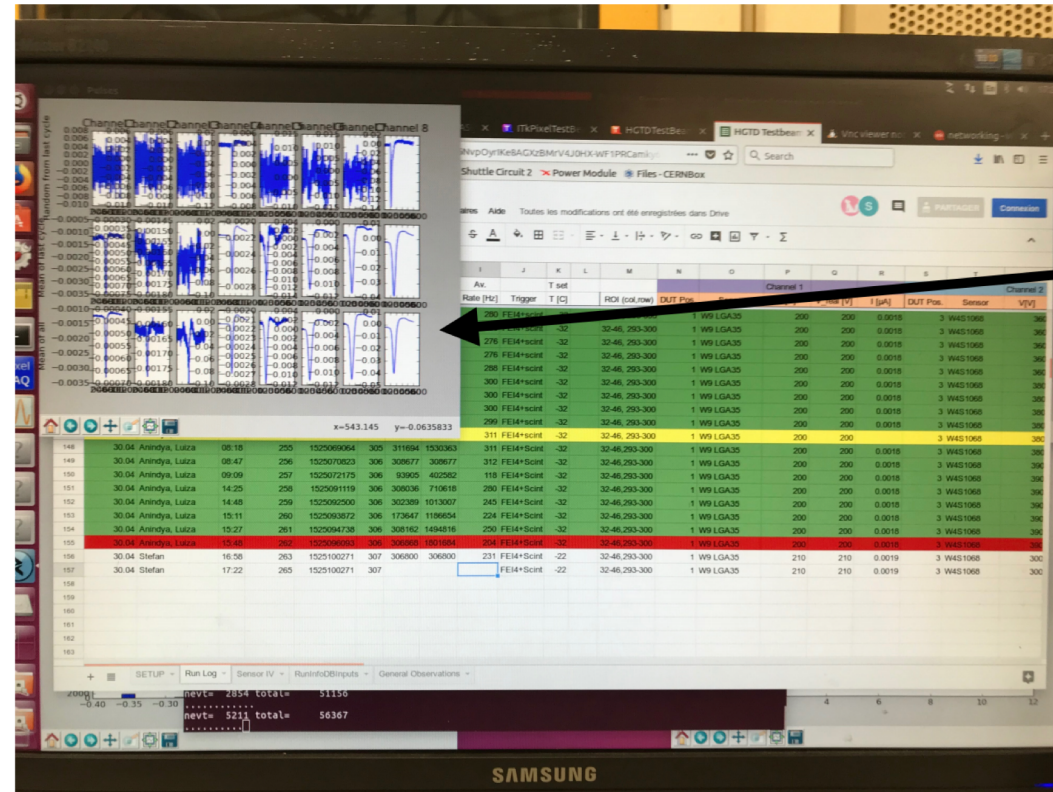
Should be ~ 300 Hz for efficient data-taking

Number of events / triggers

# What should I do as a shifter?

- Check Data Quality

- Data quality checks are run via a terminal:
- **python ~/HGTD/June18TB/Monitoring/dataMonitor.py [filename or path]**, where filename is the path to either the dat or the txt file and path is a directory (including subdirectories) to be monitored



- Several pop-up windows
- **One EXTREMELY useful is the signals from the oscilloscope channels**
- Should be checked while data-taking to spot any issues
- Should always see 2 SiPMS, reference LGAD and other signals accordingly



# What should I do as a shifter?

- Fill out the Log book
  - **It is required when a run is taken to fill out the information on the google spreadsheet**
    - Can find the link on the specific testbeam twiki page —> should be always on in the hut!
    - Fill out comments!
  - **Check run numbers (both!), rate, sensor positions with voltages and leakage currents (also SiPM)**
    - **Check these every single run!!**

The screenshot shows a Google Sheet titled "HGTDTTestbeam June 2018". The table contains the following columns: Run Number, Rate, Sensor Positions, Voltages, and Leakage Currents. The data is organized into rows, with some rows highlighted in red and others in yellow. The spreadsheet is viewed in a web browser window.

Run Number	Rate	Sensor Positions	Voltages	Leakage Currents
1	1.2	1.2	1.2	1.2
2	1.2	1.2	1.2	1.2
3	1.2	1.2	1.2	1.2
4	1.2	1.2	1.2	1.2
5	1.2	1.2	1.2	1.2
6	1.2	1.2	1.2	1.2
7	1.2	1.2	1.2	1.2
8	1.2	1.2	1.2	1.2
9	1.2	1.2	1.2	1.2
10	1.2	1.2	1.2	1.2
11	1.2	1.2	1.2	1.2
12	1.2	1.2	1.2	1.2
13	1.2	1.2	1.2	1.2
14	1.2	1.2	1.2	1.2
15	1.2	1.2	1.2	1.2
16	1.2	1.2	1.2	1.2
17	1.2	1.2	1.2	1.2
18	1.2	1.2	1.2	1.2
19	1.2	1.2	1.2	1.2
20	1.2	1.2	1.2	1.2
21	1.2	1.2	1.2	1.2
22	1.2	1.2	1.2	1.2
23	1.2	1.2	1.2	1.2
24	1.2	1.2	1.2	1.2
25	1.2	1.2	1.2	1.2
26	1.2	1.2	1.2	1.2
27	1.2	1.2	1.2	1.2
28	1.2	1.2	1.2	1.2
29	1.2	1.2	1.2	1.2
30	1.2	1.2	1.2	1.2
31	1.2	1.2	1.2	1.2
32	1.2	1.2	1.2	1.2
33	1.2	1.2	1.2	1.2
34	1.2	1.2	1.2	1.2
35	1.2	1.2	1.2	1.2
36	1.2	1.2	1.2	1.2
37	1.2	1.2	1.2	1.2
38	1.2	1.2	1.2	1.2
39	1.2	1.2	1.2	1.2
40	1.2	1.2	1.2	1.2
41	1.2	1.2	1.2	1.2
42	1.2	1.2	1.2	1.2
43	1.2	1.2	1.2	1.2
44	1.2	1.2	1.2	1.2
45	1.2	1.2	1.2	1.2
46	1.2	1.2	1.2	1.2
47	1.2	1.2	1.2	1.2
48	1.2	1.2	1.2	1.2
49	1.2	1.2	1.2	1.2
50	1.2	1.2	1.2	1.2
51	1.2	1.2	1.2	1.2
52	1.2	1.2	1.2	1.2
53	1.2	1.2	1.2	1.2
54	1.2	1.2	1.2	1.2
55	1.2	1.2	1.2	1.2
56	1.2	1.2	1.2	1.2
57	1.2	1.2	1.2	1.2
58	1.2	1.2	1.2	1.2
59	1.2	1.2	1.2	1.2
60	1.2	1.2	1.2	1.2
61	1.2	1.2	1.2	1.2
62	1.2	1.2	1.2	1.2
63	1.2	1.2	1.2	1.2
64	1.2	1.2	1.2	1.2
65	1.2	1.2	1.2	1.2
66	1.2	1.2	1.2	1.2
67	1.2	1.2	1.2	1.2
68	1.2	1.2	1.2	1.2
69	1.2	1.2	1.2	1.2
70	1.2	1.2	1.2	1.2
71	1.2	1.2	1.2	1.2
72	1.2	1.2	1.2	1.2
73	1.2	1.2	1.2	1.2
74	1.2	1.2	1.2	1.2
75	1.2	1.2	1.2	1.2
76	1.2	1.2	1.2	1.2
77	1.2	1.2	1.2	1.2
78	1.2	1.2	1.2	1.2
79	1.2	1.2	1.2	1.2
80	1.2	1.2	1.2	1.2
81	1.2	1.2	1.2	1.2
82	1.2	1.2	1.2	1.2
83	1.2	1.2	1.2	1.2
84	1.2	1.2	1.2	1.2
85	1.2	1.2	1.2	1.2
86	1.2	1.2	1.2	1.2
87	1.2	1.2	1.2	1.2
88	1.2	1.2	1.2	1.2
89	1.2	1.2	1.2	1.2
90	1.2	1.2	1.2	1.2
91	1.2	1.2	1.2	1.2
92	1.2	1.2	1.2	1.2
93	1.2	1.2	1.2	1.2
94	1.2	1.2	1.2	1.2
95	1.2	1.2	1.2	1.2
96	1.2	1.2	1.2	1.2
97	1.2	1.2	1.2	1.2
98	1.2	1.2	1.2	1.2
99	1.2	1.2	1.2	1.2
100	1.2	1.2	1.2	1.2

Thank you!